

APPENDIX A
(Substitute Claims)

51. (New) A spherical semiconductor particles mass-producing method comprising the steps of:

storing a semiconductor in a crucible;
heating and melting the semiconductor in the crucible by heating means;
dropping a molten semiconductor coming from the crucible from a nozzle in a vapor phase; and
vibrating the molten semiconductor in the crucible or the molten semiconductor dropped in the vapor phase by vibrating means.

52. (New) The spherical semiconductor particles mass-producing method of claim 51, further comprising:

pressuring the molten semiconductor in the crucible by pressuring means.

53. The spherical semiconductor particles mass-producing method of claim 52, wherein the pressurizing means is a gas source for supplying an inert gas having a pressure higher than atmospheric pressure to a space over the semiconductor in the crucible.

54. The spherical semiconductor particles mass-producing method of claim 51, wherein a pressure of a space with which an outlet of the nozzle communicates is selected to be lower than that of a space over the semiconductor in the crucible does.

55. (New) The spherical semiconductor particles mass-producing method of claim 51, wherein a plurality of the nozzles are provided and each of the nozzles has an inner diameter of 1 ± 0.5 mm and a length of 1 mm to 100 mm.

56. (New) The spherical semiconductor particles mass-producing method of claim 55, wherein each of the nozzles has a length of 5 mm to 10 mm.

57. (New) The spherical semiconductor particles mass-producing method of claim 51, wherein the heating means comprises an induction heating coil provided in the vicinity of the crucible and a high-frequency power source for energizing the induction heating coil.

58. (New) The spherical semiconductor particles mass-producing method of claim 51, wherein the heating means is resistive heating means for heating the crucible.

59. (New) The spherical semiconductor particles mass-producing method of claim 51, wherein the vibrating means has a vibration frequency of 10 Hz to 1 kHz.

60. (New) The spherical semiconductor particles mass-producing method of claim 51, wherein the vibrating means applies sound waves or ultrasonic waves to the dropping molten semiconductor and thereby vibrate the dropping molten semiconductor.

61. (New) The spherical semiconductor particles mass-producing method of claim 51, wherein the nozzle is vibratory, and the vibrating means vibrates the nozzle by reciprocating.

62. (New) The spherical semiconductor particles mass-producing method of claim 61, wherein the vibrating means drives the nozzle so that an outlet of the nozzle vibrates in a direction perpendicular to the axial line of the nozzle at an amplitude A that is smaller than $1/2$ of an outer diameter D1 of particles to be formed.

63. (New) The spherical semiconductor particles mass-producing method of claim 61, wherein the vibrating means vibrates the nozzle along the axial line of the nozzle.

64. (New) The spherical semiconductor particles mass-producing method of claim 51, wherein the vibrating means is pressure varying means for varying a pressure of a space over the semiconductor in the crucible.

65. (New) (Corresponding to current claim 28)

The spherical semiconductor particles mass-producing method of claim 64, wherein the vibrating means comprising:

a diaphragm provided so as to communicate with the space over the semiconductor in the crucible, and

a driving source for reciprocating the diaphragm.

66. (New) (Corresponding to current claim 29)

The spherical semiconductor particles mass-producing method of claim 64, wherein the vibrating means comprising:

a driving chamber that is connected to the space over the semiconductor in the crucible, and
a driving source for oscillating a pressure inside the driving chamber.

67. (New) (Corresponding to current claim 30)

The spherical semiconductor particles mass-producing method of claim 51, wherein the vibrating means vibrates the crucible.

68. (New) (Corresponding to current claim 31)

The spherical semiconductor particles mass-producing method of claim 51, further comprising:
exerting Lorentz force on the molten semiconductor dropping from the nozzle and thereby forming particles through a pinch effect of decreasing a cross-section of the molten semiconductor by Lorentz force generating means.

69. (New) (Corresponding to current claim 32)

The spherical semiconductor particles mass-producing method of claim 51, further comprising:
heating liquid or solid particles dropping from the nozzle in the vapor phase to control a cooling rate thereof and thereby converting the particles into single-crystal or polycrystalline particles.

70. (New) (Corresponding to current claim 33)

The spherical semiconductor particles mass-producing method of claim 69, further comprising:

causing crystalline semiconductor particles of one conductivity type to pass through a passage in a material gas containing atoms or molecules with which the crystalline semiconductor particles are to be doped, and thereby forming a surface layer of the other conductivity type on each of the crystalline semiconductor particles.

71. (New) (Corresponding to current claim 34)

A spherical semiconductor particles mass-producing method comprising:

crystallizing step for heating liquid or solid particles existing in a vapor phase by crystallizing means and thereby converting the particles into single-crystal or polycrystalline particles.

72. (New) (Corresponding to current claim 35)

The spherical semiconductor particles mass-producing method of claim 69 or 71, wherein the crystallizing means is a laser source for applying laser light to the particles.

73. (New) The spherical semiconductor particles mass-producing method of claim 69 or 71, wherein the crystallizing means is a radiation heat source provided adjacent to a passage of the particles, for heating the particles by radiation heat.

74. The spherical semiconductor particles mass-producing method of claim 72, wherein the crystallizing means heats the particles so that the cooling rate of the particles has a gentle profile, to thereby prevent development of cracks in the particles and prevent the particles from becoming amorphous.

75. A spherical semiconductor particles mass-producing method comprising:

causing crystalline semiconductor particles of one conductivity type to pass through a passage in a material gas containing atoms or molecules with which the crystalline semiconductor particles are to be doped, and thereby forming a surface layer of the other conductivity type on each of the crystalline semiconductor particles.

76. (New) The spherical semiconductor particles mass-producing method of claim 70, wherein the passage extends in a vertical direction and surface layer diffusion is performed as the crystalline semiconductor particles drop through the passage.

77. (New) The spherical semiconductor particles mass-producing method of claim 76, wherein the crystalline semiconductor particles on which a diffusion agent is deposited by passing through the passage are heated to form thereon a surface layer having a desired thickness.

78. (New) The spherical semiconductor particles mass-producing method of claim 70, wherein the semiconductor is silicon.

79. (New) A spherical semiconductor particles mass-producing apparatus comprising:

- a crucible for storing a semiconductor;
- heating means for heating and melting the semiconductor in the crucible;
- a nozzle for dropping a molten semiconductor coming from the crucible; and
- vibrating means for vibrating the molten semiconductor and thereby converting, in a vapor phase, the dropping molten semiconductor into spherical particles having uniform particle diameters.

80. (New) A spherical semiconductor particles mass-producing apparatus comprising:

- crystallizing means for heating liquid or solid particles existing in a vapor phase and thereby converting the particles into single-crystal or polycrystalline particles.

81. (New) A spherical semiconductor particles mass-producing apparatus comprising:

- diffusing means for causing crystalline semiconductor particles of one conductivity type to pass through a passage in a material gas containing atoms or molecules with which the crystalline semiconductor particles are to be doped, and thereby forming a surface layer of the other conductivity type on each of the crystalline semiconductor particles.